Supplemental Questions
Real-Life Stoichiometry

1. If you're a camel……
   It is a fallacy that camels store water in their humps. Their humps are actually a repository of a fat called tristearin ($C_{57}H_{110}O_6$). When tristearin is metabolized through complete combustion, not only is energy produced but so is water.

   a. Write the balanced equation for the complete combustion of tristearin.

   $$\underset{A}{2C_{57}H_{110}O_6} + 163O_2 \longrightarrow 114CO_2 + \underset{B}{110H_2O}$$

   b. The average dromedary weighs about 450kg and tristearin comprises about 15% of its total body mass. If all of the tristearin in the average dromedary was to undergo complete combustion. What mass of water would be produced?

   $$450\,kg \times 0.15\left(\frac{1000\,g}{1\,kg}\right)\left(\frac{1\,mol\,A}{891.6\,g}\right)\left(\frac{110\,mol\,B}{2\,mol\,A}\right)\left(\frac{18.02\,g\,B}{1\,mol\,B}\right) = 75000\,g \approx 75\,kg.$$

   c. The combustion of tristearin actually results in the loss of water from camel as most of this water evaporates during respiration. A camel can lose as much as 25% of its body weight from water loss and still survive. An average size camel also has the ability to drink about 200L of water in 3 minutes. If a 450kg camel were to lose 25% of its mass due to water loss, how long would it take it to regain that loss through drinking water. *Remember: density of water is 1.0 g/ml*

   $$450\,kg\left(\frac{25}{100}\right)\left(\frac{1000\,g}{1\,kg}\right)\left(\frac{1\,mL}{1.0\,g}\right)\left(\frac{1\,L}{1000\,mL}\right)\left(\frac{3\,min}{200\,L}\right) = 1.7\,minutes$$

2. If you are an automobile designer……

Air bags use a chemical reaction to inflate airbags in the event of a collision. Read this following short Scientific American article for information about how air bags work
http://www.scientificamerican.com/article.cfm?id=how-do-air-bags-work

a. Write the balanced decomposition reaction for sodium azide.

$$2NaN_3 \rightarrow 2Na + 3N_2$$

b. If it takes about 67.0L of nitrogen gas to fill an airbag perform the calculations to determine how much sodium azide is needed to create this volume of nitrogen gas. *Remember, this reaction does not occur under STP conditions so you must use the density of N_2 which is 0.916 g/L.*

$$67.0L\left(\frac{0.916g}{1L}\right)\left(\frac{1mol}{28.02g}\right)\left(\frac{2mol\ NaN_3}{3mole\ N_2}\right)\left(\frac{65.02}{1mol\ NaN_3}\right) = 94.9g\ NaN_3$$

c. One of the products of the reaction in (a) could be harmful to human beings. As a result, iron (III) oxide is added to an airbag to "neutralize" this chemical.

i. Write the balanced chemical equation for this reaction.

$$6Na + Fe_2O_3 \longrightarrow 3Na_2O + 2Fe$$

ii. What type of chemical reaction is this?

Single Replacement

iii. If 67L of nitrogen gas were produced upon impact, would 50g of iron (III) oxide be sufficient to convert all of the sodium to sodium oxide. *Hint: first determine what mass of sodium would be produced in reaction (2a) and then determine the limiting reactant in (2ci).*

$$67L\ N_2\left(\frac{0.916g}{1L}\right)\left(\frac{1mol\ N_2}{28.02g}\right)\left(\frac{2mol\ Na}{3mol\ N_2}\right)\left(\frac{22.99g}{1mol\ Na}\right) = 33.6g\ Na$$

$$33.6g\ Na\left(\frac{1mol}{22.99g}\right) = 1.46mole\ Na \quad 50g\ Fe_2O_3\left(\frac{1mol}{159.7g}\right) = 0.3g$$

3. If you are a pharmaceutical scientist......

~~haves~~ need $\frac{6mol\ Na}{1mol\ Fe_2O_3}$ Have $\frac{1.46}{0.3}$ $\frac{4.9}{1}$

Na is limitn so
50g of Fe_2O_3 is Suffiant

The production of pharmaceutical often involves multi-step complex chemical reactions that are not one hundred percent efficient. A great deal of research in the pharmaceutical industry is geared toward enhancing the efficiency drug production in order to eliminate waste and decrease the cost of medications.

Consider this hypothetical series of reactions.

$2A + B \longrightarrow 2C$ (80% efficient)

$C + 2D \longrightarrow E + 2F$ (66% efficient)

$2F \longrightarrow 4G + H$ (75% efficient)

The theoretical yield of compound G following this series of reactions would be 4 moles if each reaction were 100% efficient.

a. Assuming 100% efficiency, what would be your percent yield if you started with 5.2 moles of A and produced 8.9 moles of G?

$5.2 \text{ mol A} \left(\frac{2 \text{ mol B}}{2 \text{ mol A}}\right)\left(\frac{2 \text{ mol F}}{1 \text{ mol C}}\right)\left(\frac{4 \text{ mol G}}{2 \text{ mol F}}\right) = 20.8 \text{ mol G}$ Theoretical

$\frac{8.9 \text{ mol G}}{20.8 \text{ mol G}} \times 100 =$ 43%.

b. If you were to start with 2 moles of A, how many moles of G would be your theoretical yield given the efficiencies listed for each reaction?

$2 \text{ mol A} \left(\frac{2 \text{ mol C}}{2 \text{ mol A}}\right)\left(\frac{80}{100}\right)\left(\frac{2 \text{ mol F}}{1 \text{ mol C}}\right)\left(\frac{66}{100}\right)\left(\frac{4 \text{ mol G}}{2 \text{ mol F}}\right)\left(\frac{75}{100}\right) = \sim 3_{2} \text{ moles}.$

c. If you needed to produce 4 moles of G with these inefficiencies, how many moles of A would you need to start with?

$4 \text{ mol G} \left(\frac{100}{75}\right)\left(\frac{2 \text{ mol F}}{4 \text{ mol G}}\right)\left(\frac{100}{66}\right)\left(\frac{1 \text{ mol C}}{2 \text{ mol F}}\right)\left(\frac{100}{80}\right)\left(\frac{2 \text{ mol A}}{2 \text{ mol C}}\right) = 2.5 \text{ mol A}.$

$\frac{2}{3}$ $\frac{x}{4}$